

New deposition facility at RIT for coating large EUVL optics

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Overview

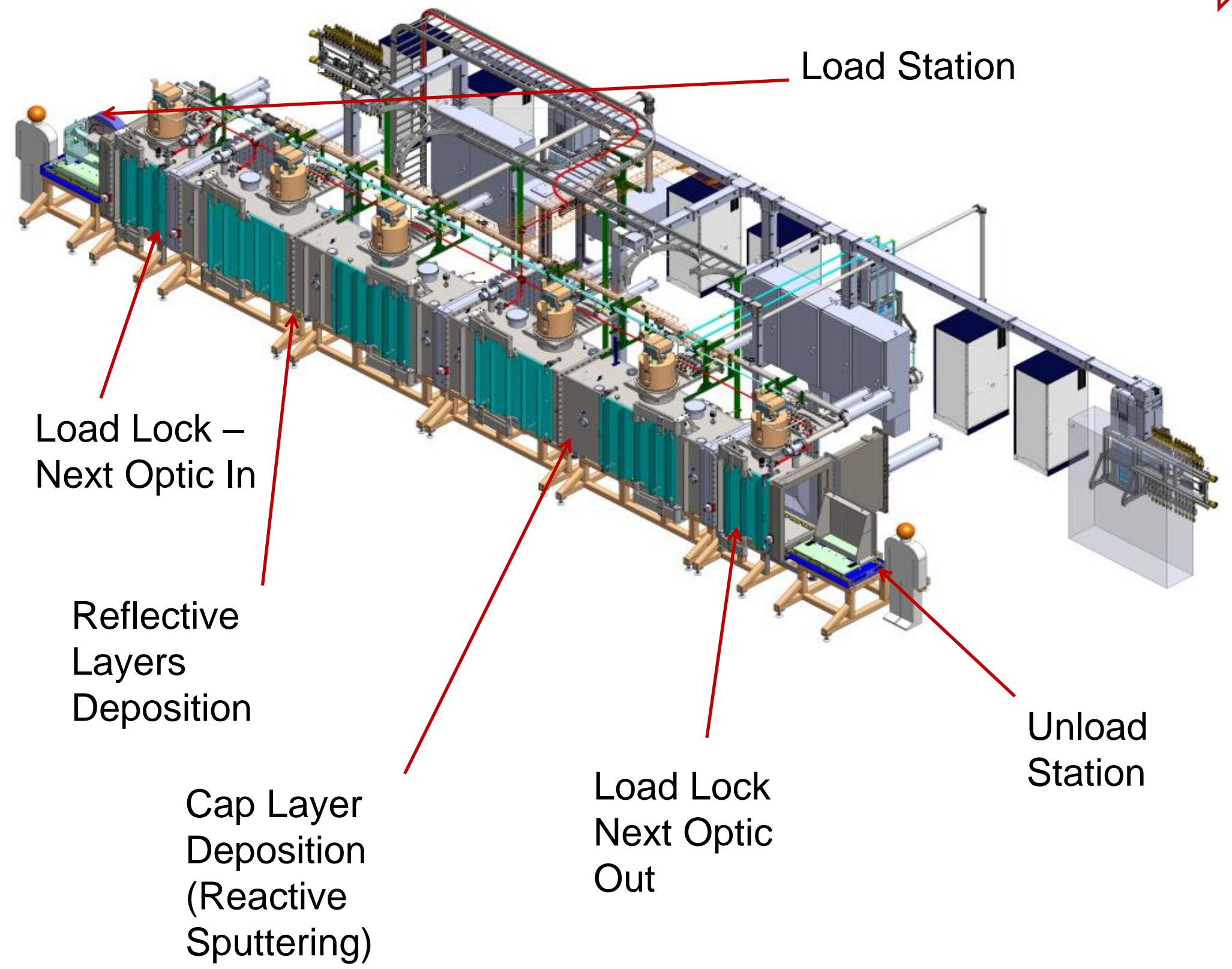
In order to increase the capability to supply optics to the EUVL industry, RIT has installed an high-volume manufacturing (HVM) magnetron-sputtering deposition facility in Auburn Hills. Installed in 1Q-2014, the Inline-2 expands on the 17-year history of operational learning with the Inline-1 system (exclusive to RIT). The new system is thorough upgrade featuring:

- Dual Process Chamber & Dual Load-Lock UHV (independent operation – 4 magnetrons in each)
- Full reactive-deposition capability
- Up to 750mm diameter x 400mm thick (radially-graded or 2D-graded)
- Advanced pumping systems, including heating & polycold
- Fully-equipped for multiple gas lines
- State of the art motion control
- Ion-milling and supermirror capability
- Class 1000 cleanroom with Class 100 capability at load stations

The system will be capable of high-throughput sequential deposition with up to 4 optics simultaneously in process, or each process chamber can be operated fully independently. The total facility improvement measures 3500 ft² including support rooms for cleaning, refurbishment and metrology.

This poster details the initial results of the Inline-2 system.

Production Flow – 4 optics simultaneously in process

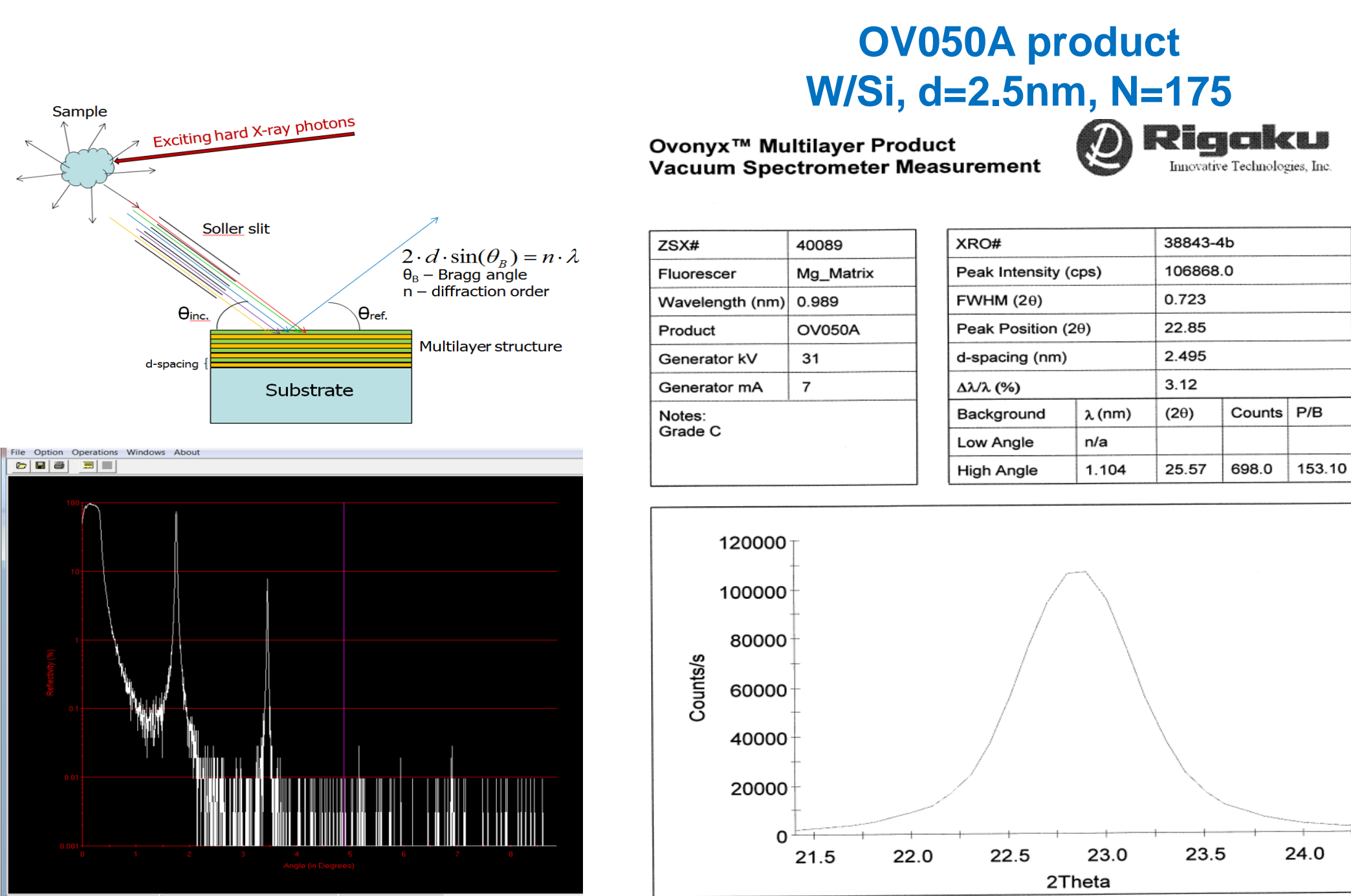


Comparison of Inline Systems

Parameter	Inline G2	Inline G1
Home position	≤ 0.05mm	± 0.2mm
Velocity vs. position repeatability	≤ 0.05%	~ 5x worse
Pump down time	24 hours	48 hours
Base pressure	1x10 ⁻⁸ Torr	1x10 ⁻⁷ Torr
Target size	30 inches	20 inches
Max. speed of carrier	150 mm/s	100 mm/s
Max. acceleration	150 mm/s ²	10 mm/s ²
Reactive sputtering	yes	limited

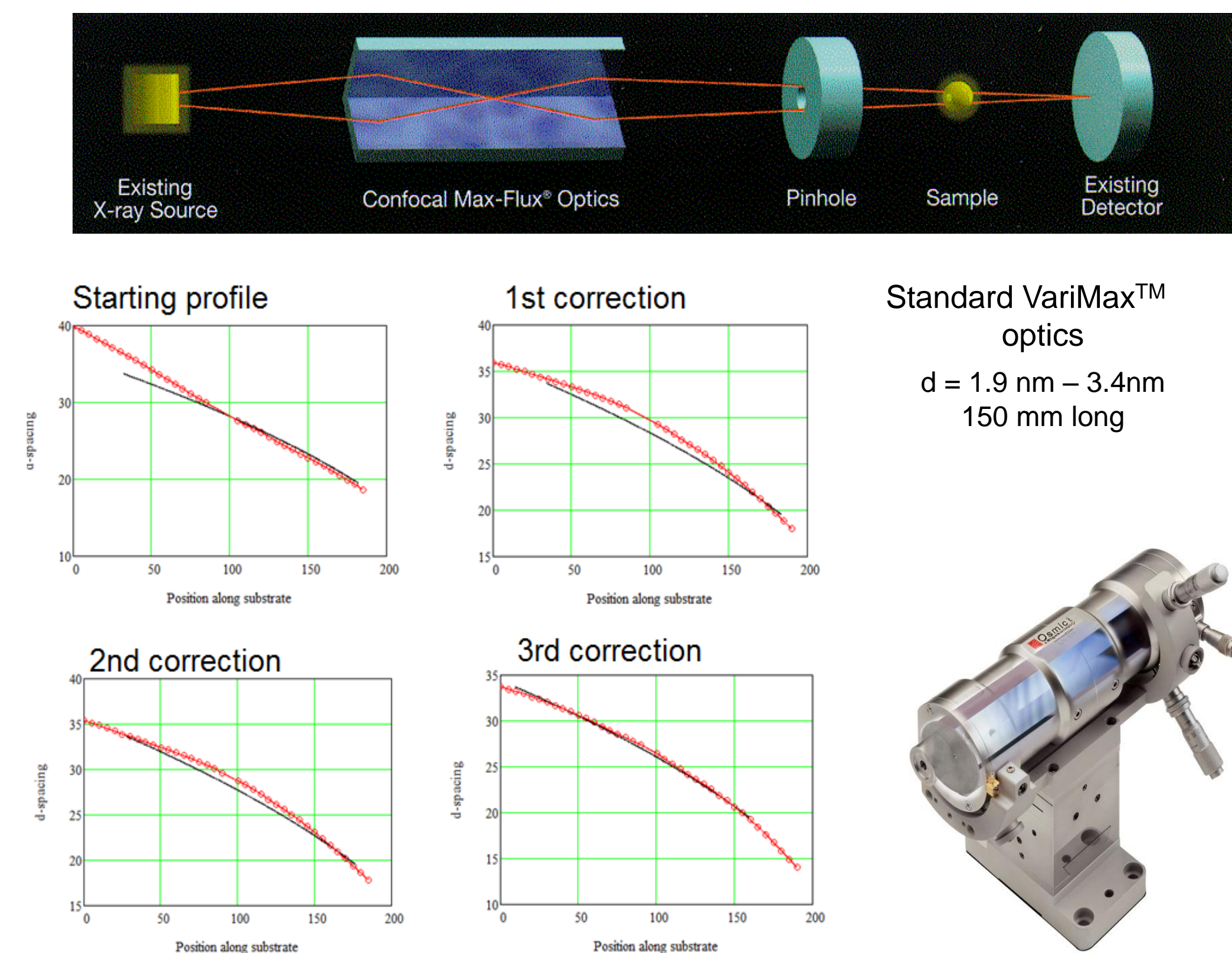
Standard OVONYX™ on Inline-2

These are uniform-graded (constant period) multilayer optics used as analyzers.

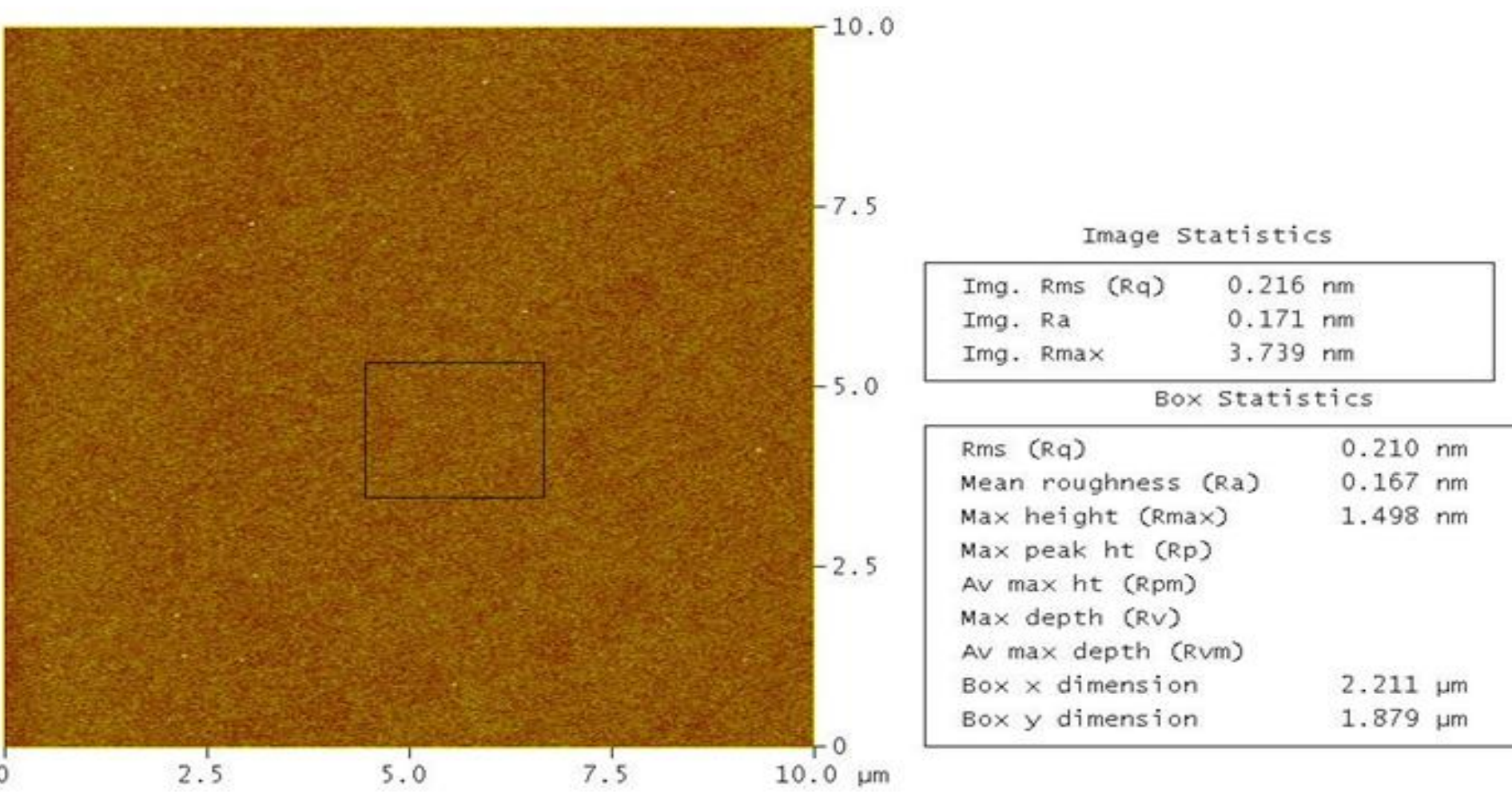


Standard MF/CMF on Inline-2

These are linear (1D) graded multilayer optics with use machined apertures in front of the magnetron targets to shape the deposition flux onto the substrates.



AFM results of MoSi with 60 bilayers



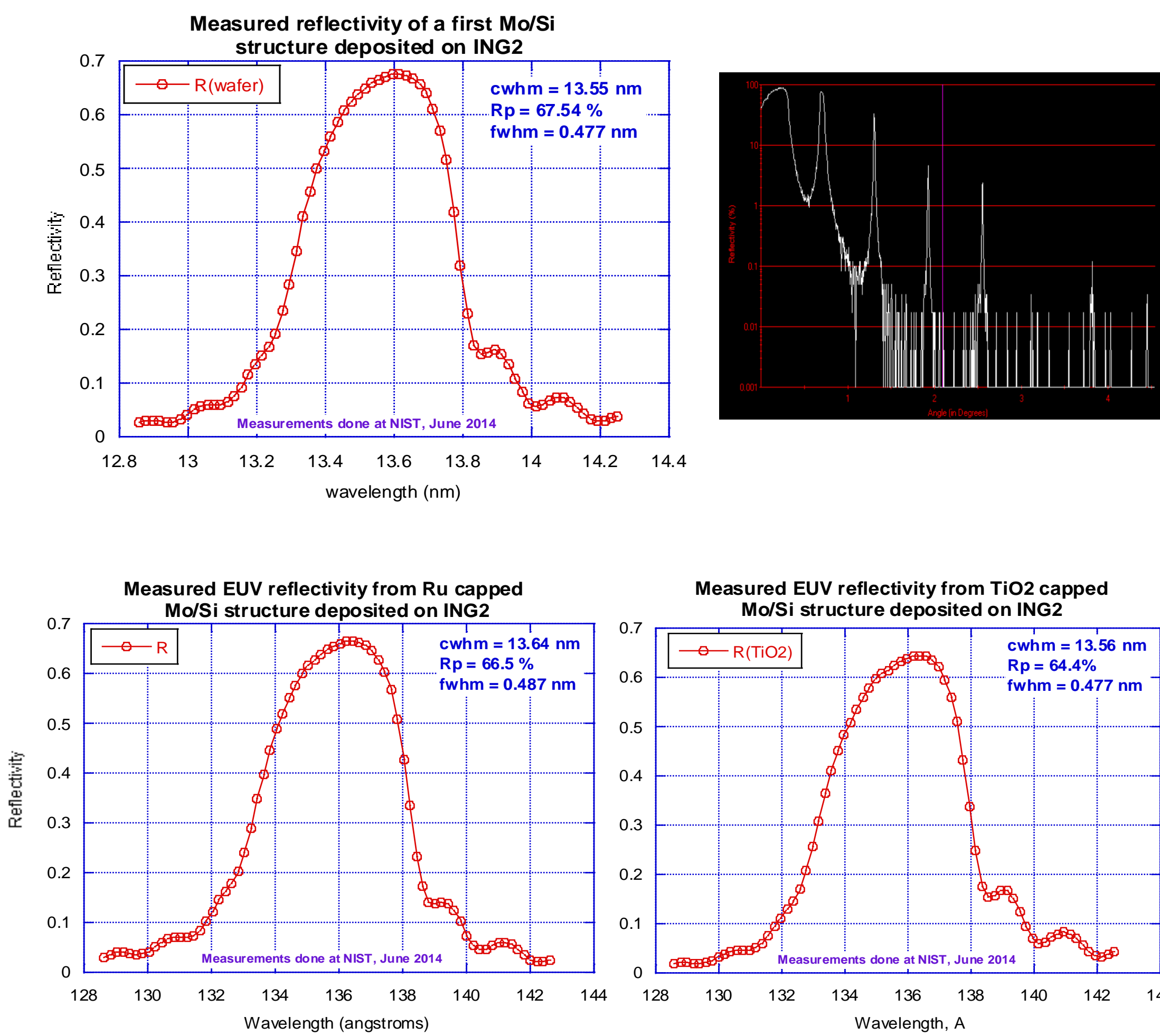
MoSi Multilayers on Inline-2

The initial characterization of the EUVL performance is with MoSi multilayers without the use of interface-stabilizing interlayers.

Standard “uncapped” multilayers are terminated with an Si-layer that self-oxidizes upon exposure to the ambient non-vacuum environment, and alternately, when oxygen was flowed within the process chamber after the topmost Si-layer deposition.

These are compared to Ru-capped and TiO_x-capped, each nominally 2nm thick. In particularly, these cap layers are not yet optimized for performance.

All results were characterized by the NIST Reflectometry facility.



First multilayer results on the Inline-2 (no barrier layers; cap layers unoptimized)

Refurbish/Cleaning Facility

Enhanced ability to clean & refurbish damaged optics via wet chemical etching has also been installed.



New Etch/Clean system

- 7 Teflon baths
- Up to 250 mm optics
- Programmable process
- Temperature up to 140°C
- High frequency ultrasonic
- Recirculating pumping

Branson's cleaning system

- 2 stainless steel baths
- Up to 450 mm optics
- Ultrasonic
- Recirculating pumping
- Temperature up to 90°C



Summary

Initial results of the newly installed deposition facility for coating large EUVL optics with the Inline-2 system have improved upon the existing Inline-2. Continuing work to quality results on large optics & optimize both interface-stabilization and cap-layer is in progress.

RIT would like to thank Charles Tarrio, Steve Grantham and Tom Lucatorto at NIST for their valuable partnership in these efforts.